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Balaban

[11] **4,348,024**

[45] **Sep. 7, 1982**

[54] **RACKET STRINGING APPARATUS AND METHOD**

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[21] Appl. No.: **115,258**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 11,145, Feb. 12, 1979, Pat. No. 4,249,732, and Ser. No. 99,215, Dec. 3, 1979, Pat. No. 4,326,713.

[51] **Int. Cl.**[3] **A63B 51/14**

[52] **U.S. Cl.** ..... **273/73 A**

[58] **Field of Search** ..... 273/73 A, 73 B; 73/145; 242/147 R, 149; 269/157, 233, 236; 144/286 R; 51/166 R, 166 TS, 166 FB, 241; 254/249–263

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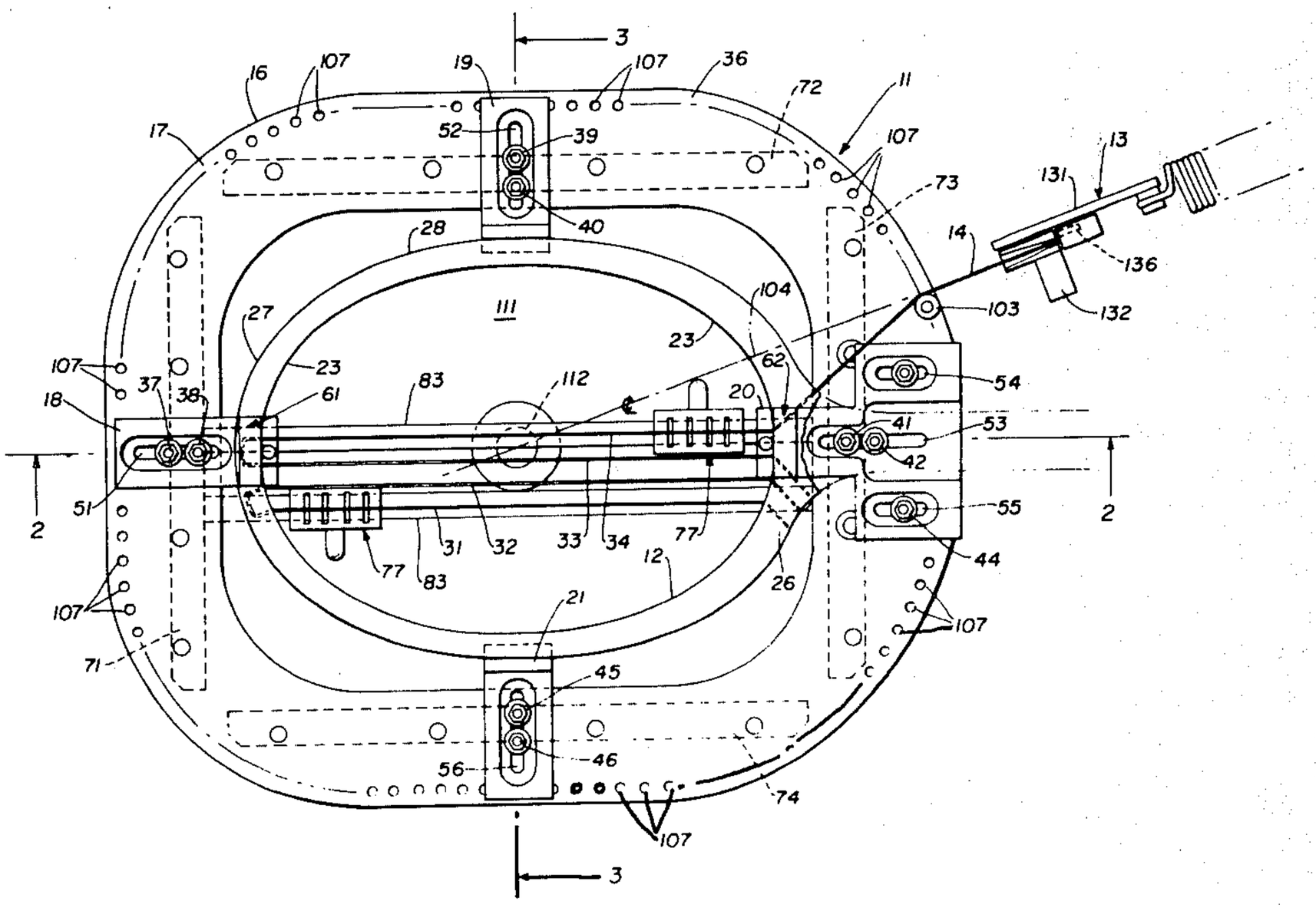
[57] **ABSTRACT**

A racket stringing apparatus having an open racket head frame holding fixture and means for tensioning a string drawn across the open area of the head frame wherein the fixture is formed as an annulus circumscribing the racket head frame and the latter is rigidly supported interiorly at its yoke and distal ends and exteriorly at its intermediate opposite sides. The conventional string holding clamp is rigidly supported by and in closely coupled relation to the racket head supporting member for minimizing deflection. The head holding fixture is combined with a rotating structure including a conveniently positioned tool supporting tray. A string guide roller ensures aligned passage of the string being tensioned through the racket head openings and proper automatic rotative orientation of the fixture during tensioning of the string. The apparatus further includes an improved string tensioning clamp.

16 Claims, 8 Drawing Figures



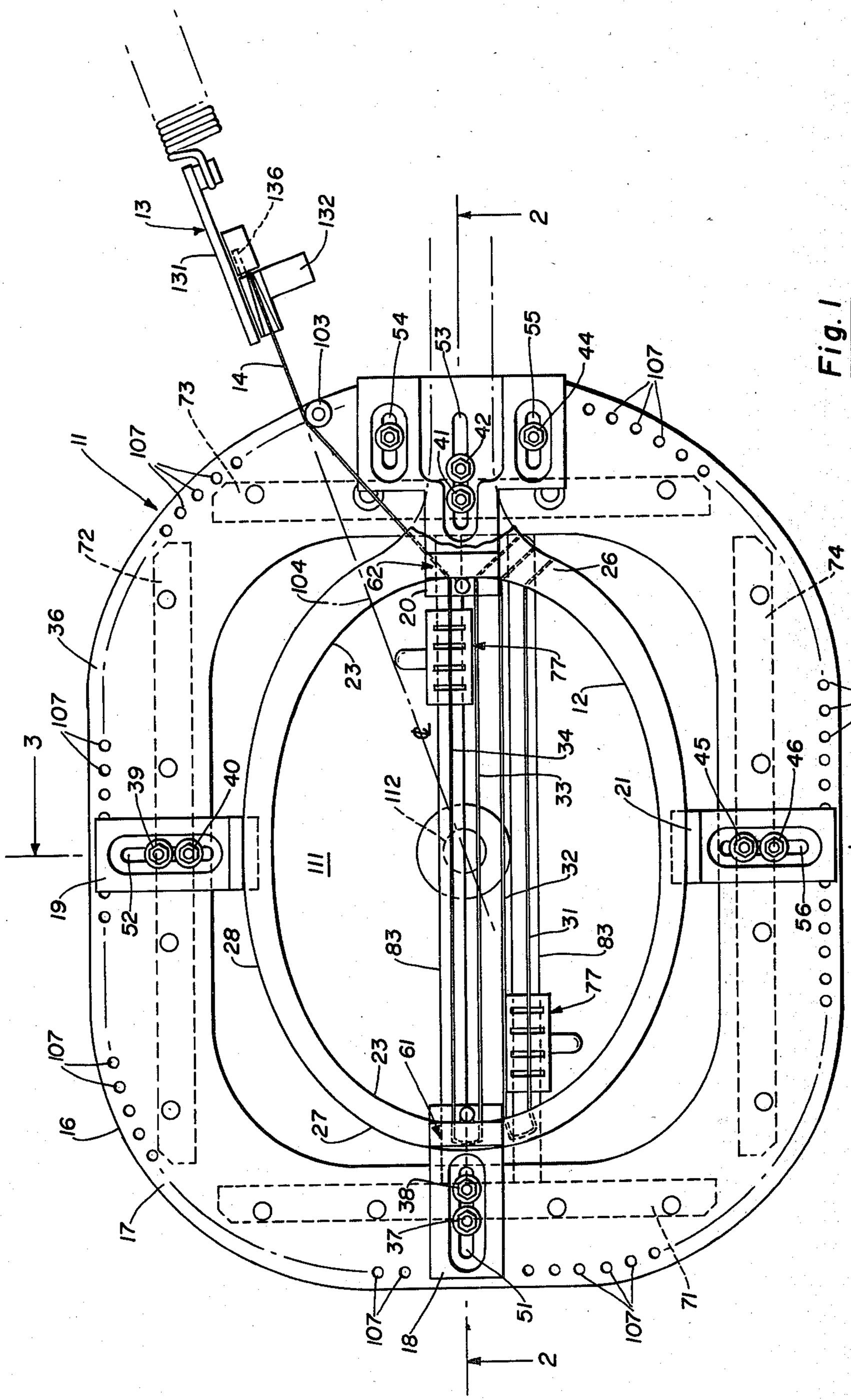

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Fig. 1

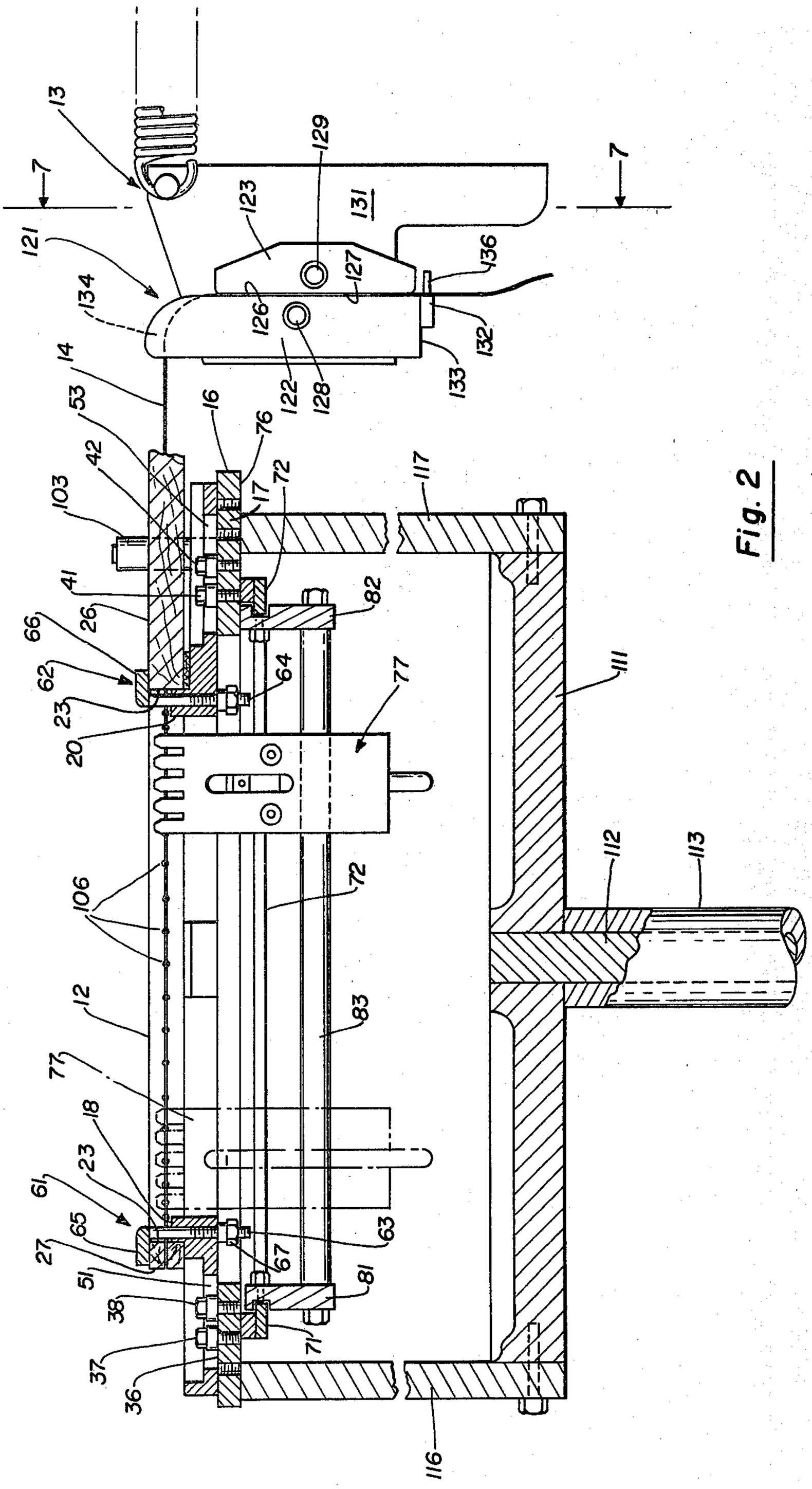
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Fig. 2

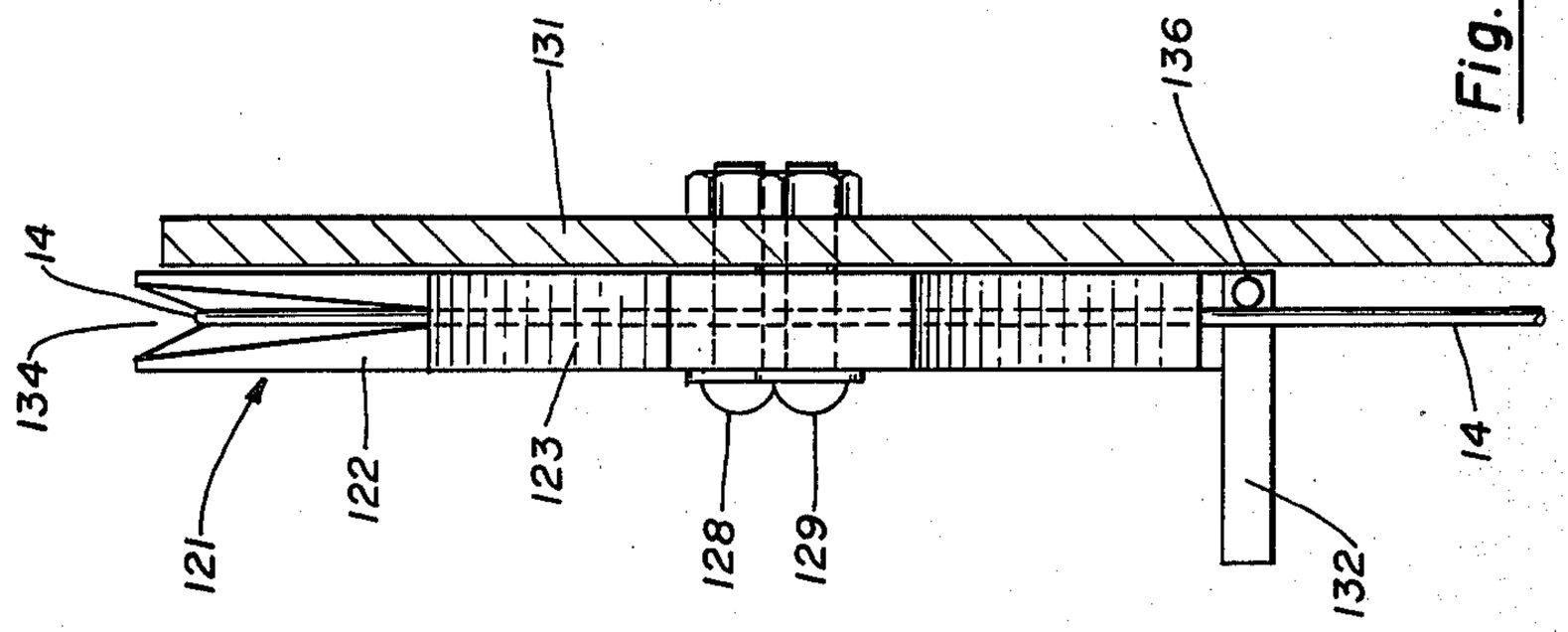
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Fig. 7

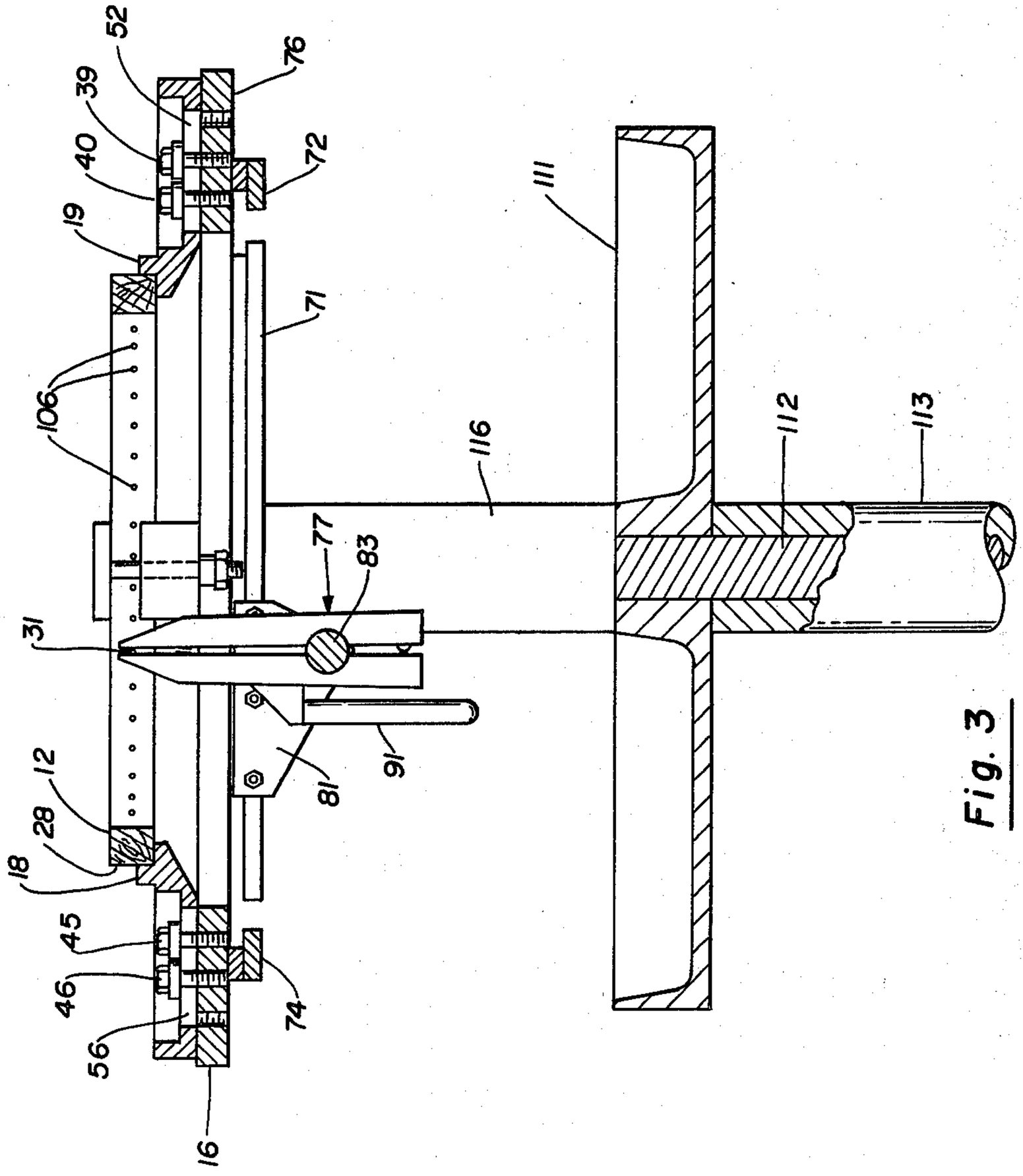
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Fig. 3

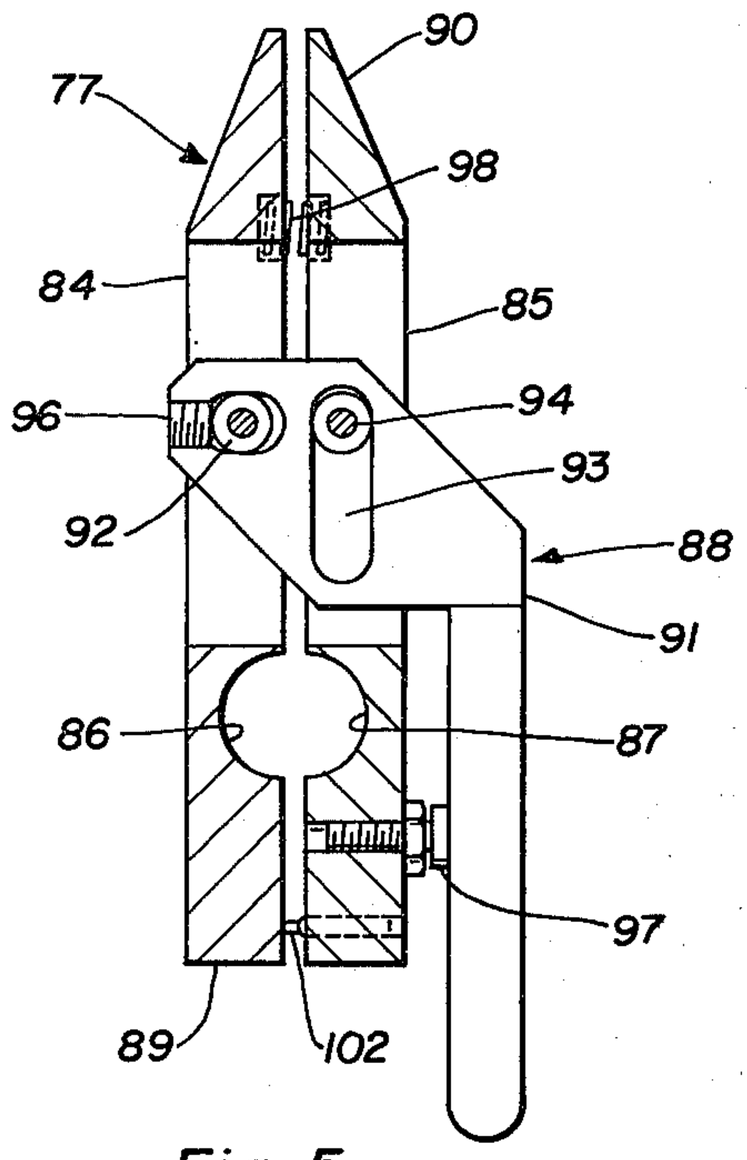

Fig. 5

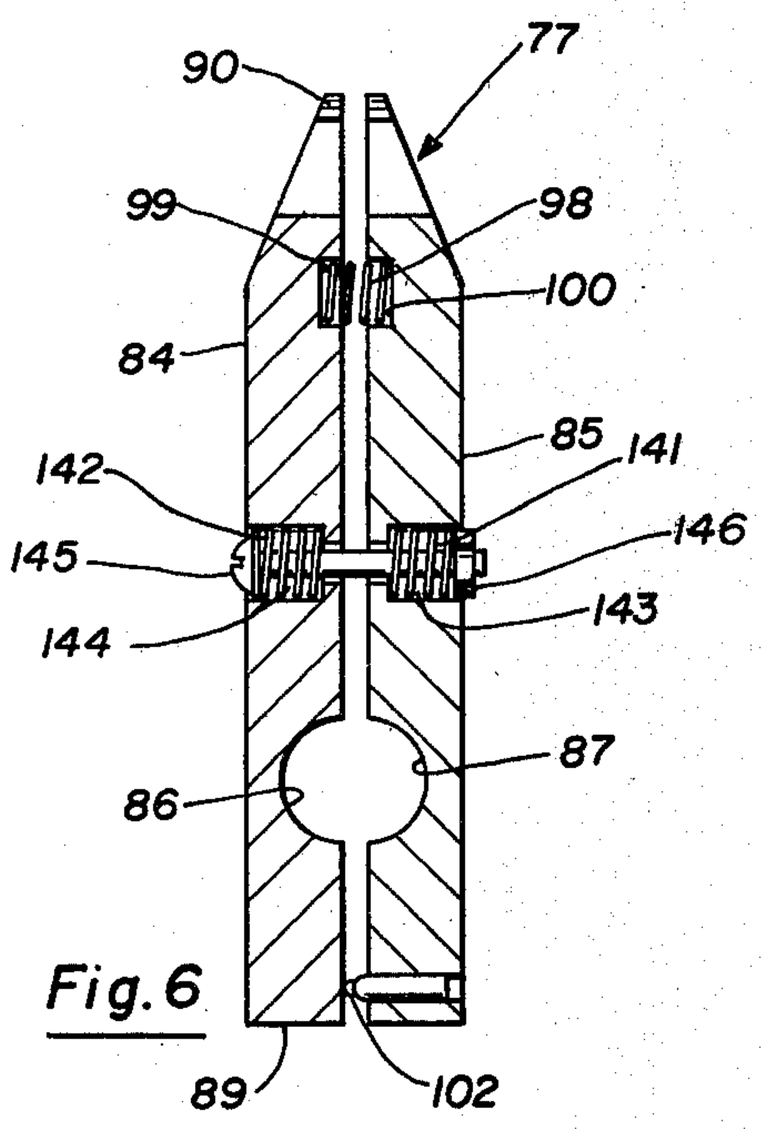

Fig. 6

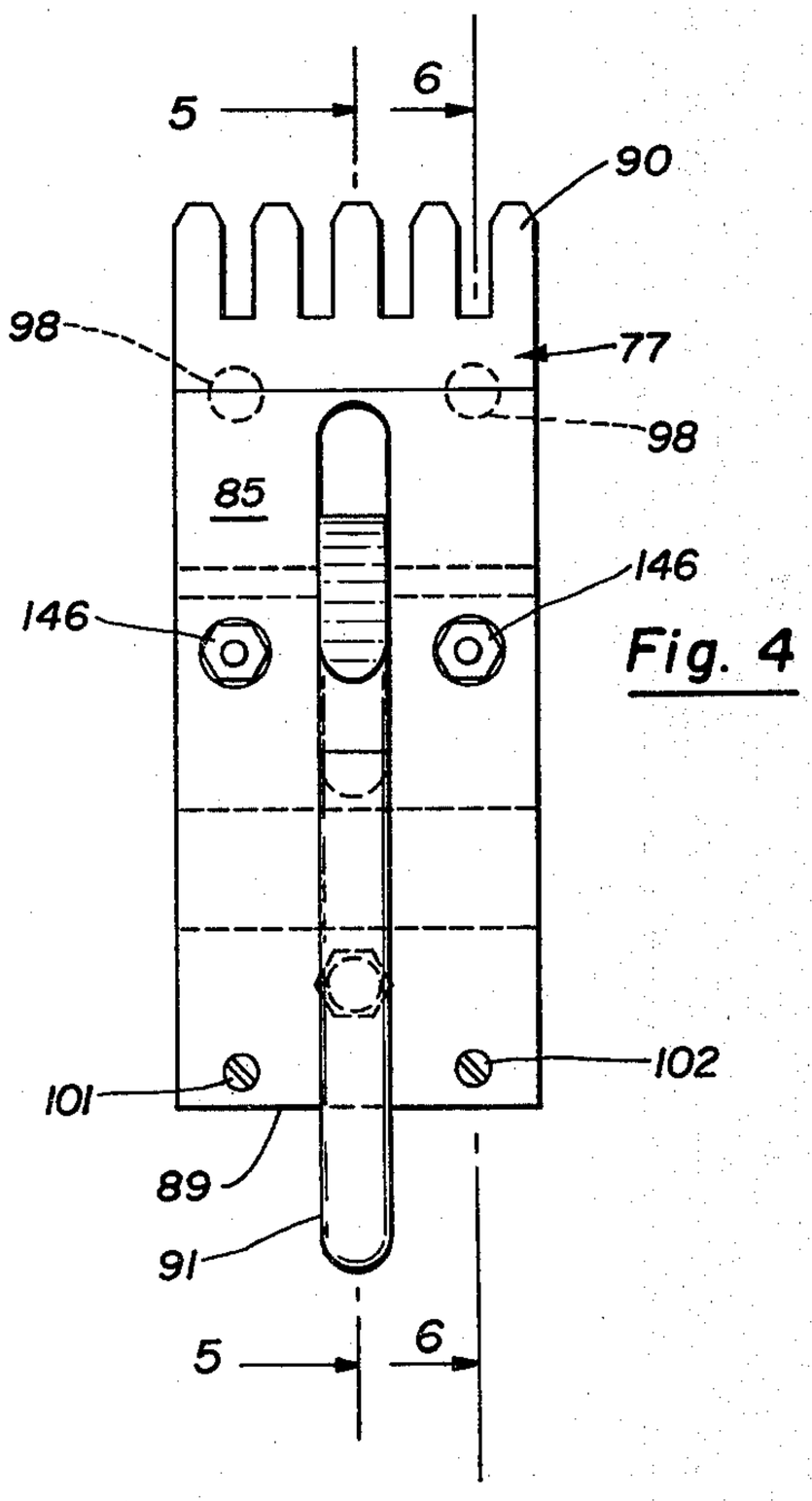

Fig. 4

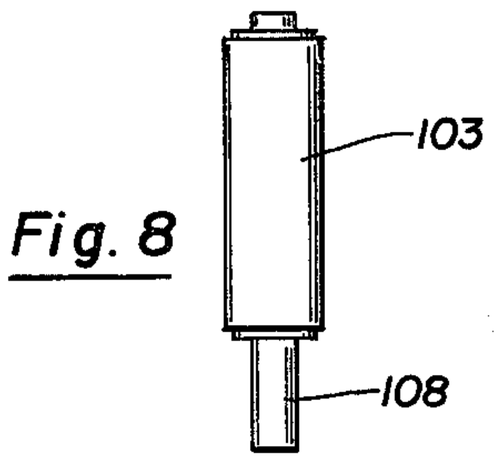

Fig. 8

RACKET STRINGING APPARATUS AND METHOD

This application is a continuation in part of applications Ser. Nos. 011,145 and 099,215 filed Feb. 12, 1979 and Dec. 3, 1979, respectively and now U.S. Pat. Nos. 4,249,732 and 4,326,713, respectively.

BACKGROUND OF THE INVENTION

1. Field of Invention

The invention relates to machines used for stringing tennis rackets and the like and particularly to those machines which incorporate structure designed to assist in the obtaining of the desired objective of a uniform tensioning of the strings.

2. Description of Prior Art

For prior art disclosures of similar types of racket stringing apparatus see U.S. Pat. Nos. 2,069,736; 2,067,563; 2,154,870; and 3,441,275. These show apparatus of a nature only generally similar to that herein shown, lacking specific features of advantages referred to in the Abstract and hereinafter further described and claimed. More particularly, the supports for holding the racket during the stringing operation are structured in a manner permitting minor but critical flexing thus affecting the resulting string tension, and uniformity of tensioning, and failed to hold the racket head frame against small but critical deflection which likewise affects the tensioning of individual strings and the string-to-string tension across the playing face of the racket. Variations of tension from string to string in rackets strung on prior art machines may vary as much as 10 to 15 pounds. In such case, the primary driving force is imparted to the ball by the tight strings with the looser strings more or less riding free. The presence of adjacent relatively tight and loose strings causes a shift in the direction of exiting of the ball from the racket; and it will be apparent that only a very small angle of error of the ball leaving the racket will produce an error of several feet as the ball reaches the opponent's back court. In tennis and similar games, optimum accuracy in ball placement is critical. Where the racket head is permitted to move or bow during stringing, strings which are placed will be subsequently relaxed if later placed strings shorten the distance across the racket head either longitudinally or transversely. Normally, the main or longitudinal strings are first placed in the racket head. If the racket head is allowed to distort during the placement of the longitudinal strings, the addition of each string reduces the tension of every string that is already in place, thus creating a variation of tension from string to string. When the cross strings are placed in the racket head, an increase in tension of the main strings will normally occur, but the difference in tension from string to string is not corrected.

Other stringing errors may be introduced by the string clamps used to anchor the string as it is tensioned within the racket head and to engage and apply the tensioning force to the string. Prior art structures have permitted minor but critical displacement of the former, and have frequently produced a crushing and damaging of the string in the case of the latter, both of which affect the tensioning and overall quality of the racket.

SUMMARY OF THE INVENTION

The racket head holding structure of the present invention comprises a very rigid annulus circumscribing the racket head frame and carries in close coupled relation thereto both the head supporting members and the required string clamp. Also, importantly, the supporting members are arranged to engage and support the interior surface of the racket head frame at its yoke and distal ends, thus rigidly supporting the longitudinal dimension of the head during installation of the longitudinal strings. At the same time the supporting members are disposed to engage and support the exterior surfaces of the head frame at its opposite sides between its yoke and distal ends thus rigidly retaining the transverse dimension of the head against expansion during installation of the longitudinal strings. As a result, uniformity of tension from string to string may be obtained thus bringing more strings into play causing the racket to play with greater power, efficiency, and accuracy.

Another important advantage in obtaining greater uniformity in tensioning of the strings is to upgrade the playing quality of nylon strings, substantially narrowing the normal gap which has existed between the playing qualities of gut and nylon strings. Nylon string is less resilient than gut and does not stretch as well so that the impairment in playing quality of the racket strung with nylon string is accentuated, as compared to gut, with racket head distortion. While a gut string is thought to play better than a nylon string, stringing of a racket with the greater uniformity in tension obtained by the apparatus of the present invention will bring the nylon play closer to that of gut. In all instances, greater uniformity in tensioning of the strings, nylon or gut, results in greater power, improved accuracy, and a considerably larger "sweet spot" or playing area of the racket. For similar reasons, it is possible with the apparatus of the present invention to obtain a heretofore unobtainable uniformity of tension for both heavy and light gauge strings.

Another cause for string tensioning error is in the frictional binding of the string as it is pulled through the openings in the racket head frame. One of the features of the present invention is the provision of novel string guide means for aligning the tensioning force with the longitudinal axis of the openings in the racket head frame thus obtaining a friction-free drawing of the string through the openings without binding and attendant problems in obtaining uniform tensioning of the strings. At the same time, the string guide means will automatically rotate the head holding fixture to proper position without requiring the operator to set a hand brake to hold the fixture in proper position for each pass of the string through the racket head.

Also included in the racket head holding fixture is a conveniently accessible tool tray which is integrated in the structural support for the fixture.

The invention possesses other objects and features of advantage, some of which of the foregoing will be set forth in the following description of the preferred form of the invention which is illustrated in the drawings accompanying and forming part of this specification. It is to be understood, however, that variations in the showing made by the said drawings and description may be adopted within the scope of the invention as set forth in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a plan view of the portion of a racket stringing apparatus constructed in accordance with the present invention.

FIG. 2 is a cross-sectional view taken substantially on the plane of line 2—2 of FIG. 1.

FIG. 3 is a cross-sectional view taken substantially on the plane of line 3—3 of FIG. 1.

FIG. 4 is an enlarged front elevation of one part of the machine.

FIG. 5 is a cross-sectional view taken substantially on the plane of line 5—5 of FIG. 4.

FIG. 6 is a cross-sectional view taken substantially on the plane of line 6—6 of FIG. 4.

FIG. 7 is a cross-sectional view on an enlarged scale taken substantially on the plane of line 7—7 of FIG. 2.

FIG. 8 is a side elevation on an enlarged scale of the string guide forming part of the apparatus.

DETAILED DESCRIPTION OF THE INVENTION

The apparatus illustrated in the accompanying drawing comprises a racket head frame holding fixture **11** for an open racket head frame and means **13** for tensioning a string **14** drawn across the open area of head frame **12**. The tensioning means may be any of the types known in the art. Reference is here made to the improved string tensioning structure disclosed and claimed in my co-pending application for RACKET STRINGING APPARATUS AND METHOD filed Dec. 3, 1979, Ser. No. 099,215. The racket head holding fixture here comprises, briefly, an open center frame member **16** having an annulus **17** dimensioned for circumscribing the racket head frame **12**; a plurality of head supporting members **18, 19, 20** and **21** mounted on member **16** for movement across annulus **17** for engagement with and for radial support of head frame **12**; supporting members **18** and **20** being mounted for engagement with the interior surface **23** of the head frame at its yoke and distal or upper ends **26** and **27**; and supporting members **19** and **21** engaging the exterior surface **28** of the head frame at its opposite sides between the yoke and distal ends. In order to generate sufficient strength and to provide for other features of the present invention, frame member **16** is preferably formed as a flat annular plate having a wide planar annulus **17** completely surrounding the racket head to be strung and providing optimum resistance to radial distortion. The head supporting members **18–21** are mounted on the top flat surface of the annulus for movement transversely thereof to and from the racket frame in closely coupled relation to the plane of the frame. Accordingly, supporting members **18–21** have a minimum offset from the plane of frame **16** thereby avoiding any error in tensioning as might be otherwise introduced by deflection of the supporting members under stress. The specific four point support of the racket head frame, i.e. interiorly at its yoke or bow end and at its distal or upper end and exteriorly at midway points on the opposite sides. It is customary to initiate the stringing of the racket head by first placing and tensioning the main or longitudinal strings, starting from adjacent the center of the racket, as shown by longitudinal strings **31, 32, 33** and **34**. As the main strings are threaded through the customary openings in the racket head frame and tensioned, the racket head frame will be squeezed in from top to bottom and forced out from side to side. The present supporting structure retains the precise designed shape of the racket frame since the noted frame distortion is prevented by the placement of supports **18–21**. As the cross strings are placed and tensioned, the pressure of the racket head frame against supports **18–21** will lessen to zero so that the racket head frame will have its designed shape after all of the strings are placed and tensioned and the racket head removed from the fixture.

Preferably, and as here shown, head supporting members **18–21** are attached to frame member **16** in a manner permitting relative swivel adjustable movement of the supporting members for full-face engagement with the racket head frame surfaces. As will be observed, supporting members **18–21** are in the form of slides mounted on the top surface **36** of annulus **17** and retained thereon by bolts **37** and **38** in the case of member **18**, bolts **39** and **40** in the case of member **19**, bolts **41, 42, 43** and **44** in the case of member **20**, and bolts **45** and **46** in the case of member **21**. Member **18** is formed with an elongated passageway **51** for receipt of bolts **37** and **38**, and in a similar manner, members **19–21** are formed with elongated passageways **52, 53, 54, 55** and **56** for receiving bolts **39–46**. In each instance, the passageways **51–56** are elongated transversely to the annulus **17** so as to permit sliding of the respective support members on the annulus to and from the racket head frame. Also in each instance the diameter of bolts **37–46** is somewhat less than the width of passageways **51–56** thus permitting some swivel action of the support permitting its advance into full-face engagement with the racket head frame surface. Racket head hold-down clamps **61** and **62** are preferably mounted on members **18** and **20** to secure the racket head against vertical displacement in the head holding fixture. As here shown, these clamps comprise threaded bolts **63** and **64**, see FIG. **2**, mounted through vertical openings in members **18** and **20** and having offset heads **65** and **66** formed to overly the adjacent tennis racket frame and being fitted at the underside of the supporting members with nuts **67** and **68** for tightening down the offset heads **65** and **66** against the upper side of the racket head frame.

In the process of stringing a racket, it is of little value to tension each string with great accuracy and consistency if the design of the string holding clamps and the string holding clamp supports is incapable of retaining that accuracy and consistency during the stringing process. The string holding clamps and their supporting system in the present machine is designed to minimize losses and variables in the string tension. This is here effected by the provision of means, specifically rails **71, 72, 73** and **74** which are fastened directly to the underside **76** of annulus **17**, for supporting one or more string clamps **77** for movement to a succession of parallel positions across the open area of the racket head frame parallel to the longitudinal and transverse axes thereof. As will be observed from FIG. **1**, rails **71–74** function as guides positioned in pairs with rails **72** and **74** positioned parallel to the longitudinal axis of the racket head frame adjacent the opposite sides thereof and a second pair of rails **71** and **73** being positioned parallel to the transverse axis of the racket head adjacent the yoke and distal ends thereof. Carriage members **81** and **82**, see FIG. **2**, are formed for longitudinal reciprocation on the guide rails and a rod **83** is mounted with its opposite ends secured to a pair of carriage members. Two assemblies are typically used, one spanning and mounted on rails **71** and **73** and the other being dimensioned for mounting on rails **72** and **74**. The rails are positioned with open space between their adjacent ends so that the proper rod and carriage assembly may be readily slipped onto or removed from each pair of guides.

String clamp **77** is best seen in FIGS. **4, 5** and **6** and comprises, briefly, a pair of opposed sections **84** and **85**

adapted to receive and clamp therebetween a string to be tensioned and having opposed recesses **86** and **87** dimensioned for fitting about opposed portions of rod **83** for longitudinal reciprocation thereon and for movement of the sections together into locked position on the rod; and manually operable means **88** for displacing the sections from and to each other to respectively permit movement of the sections along the rod to desired position and to receive a string therebetween, and to simultaneously lock the sections in position on the rod and to clamp the spring. As here shown, recesses **86** and **87** are positioned adjacent one end **89** of the sections and the latter are formed at their opposite end **90** to receive a string, and means **88** has its operating connections to sections **84** and **85** intermediate ends **89** and **90**. Means **88** here comprises a lever **91** having a loss motion pivotal connection **92** to section **84**, and the other section **85** and lever having an interfitting cam slot **93** and follower **94** mounted therein whereby arcuate displacement of the lever about pivotal connection **92** will effect displacement of sections **84** and **85** to and away from each other. Set screw **96** and stop **97** engaging lever **91** determine the maximum closing movement of the sections. Preferably, a pair of springs **98** mounted in opposed recesses **99** and **100** adjacent the normally upper end **90** of the clamp, and springs **141** and **142** mounted in recesses **143** and **144**, see FIG. **6**, medially of the sections and retained by adjustable bolt and nut members **145** and **146** in sections **84** and **85** function to bias the sections to open position. As will be observed from FIG. **4**, the biasing springs **98** and **141**, **142** are positioned on opposite sides of centrally positioned lever **191**. As here shown, springs **98**, **141** and **142** are mounted above rod retaining recesses **86** and **87** and function to normally produce a fulcruming contact of the lower end **89** of the sections in the movement of the sections to and away from each other, the springs and means **88** permitting forced manual separation of the sections at end **89** for mounting onto and removal from rod **83**. Preferably, a pair of spring-loaded plungers **101** and **102** on opposite sides of lever **191**, see FIGS. **4** and **6** are mounted at the base end **89** of the sections to ensure opening of the sections sufficient to obtain smooth, easy sliding of the clamp along the rod. A close coupling of the clamp support to the underside of the top plate **16** permits the use of a short and very rigid string clamp which grips very tightly on the glide rods **83** without damaging the strings. The body of the clamp is also designed to allow the metal to bend or flex in the plane perpendicular to rod **83** as the clamping force is applied to reduce the need for adjusting the clamp for changes in string diameter.

As another feature of importance in the present structure, friction between the string and racket head is reduced by the use of a string guide **103** which is mounted on frame member **16** in position to align the pull of the string with the length of the opening in the racket head through which the string is drawn. Another function of the guide is to automatically dispose the line of pull between the guide and tensioning means **13** to intercept a central axis of rotation about which the fixture may revolve, see phantom line **104** in FIG. **1**. In the present structure, guide **103** may be positioned on annulus **17** externally of the racket head frame so as to provide the proper alignment of pull when tensioning the string through substantially all of the openings **106** in the racket head frame and in each instance to automatically align the line of pull between the guide and the tensioning means to intercept the central rotating axis of the fixture. As here shown, see FIGS. **1**, **2** and **8**, guide **103** comprises a roller member positionable on the annulus adjacent to and having its periphery aligned with each of the openings. This is accomplished by providing the annulus with a plurality of peripherally spaced openings **107** and providing roller member **103** with a shank **108** formed for detachably mounting in each of openings **107**. The alignment of forces provided by string roller guide **103** eliminates the need for the conventionally used brake to prevent the fixture from turning while the string is being tensioned.

Another feature of the present apparatus is the incorporation in the rotating head structure of a tool tray **111** disposed directly below the working area for very easy access to stringing tools. Since all of the string-engaging structure is carried by the top plate, there is no need, as in earlier racket stringing machines, to extend string clamps and other supports up from a base structure. Thus, the area under top plate **16** is open and accessible. As here shown, a tool tray **111** is secured to member **16** in dependent, substantially parallel relation thereto; a shaft **112** is secured and depends from the tray to form the rotating axis for the top fixture; and a bearing **113** is provided as part of the base support for the machine and functions to journal shaft **112** for rotation. Tool tray **111** may be secured to top plate **16** by a pair of vertically set arms **116** and **117** bolted top and bottom to plate **16** and tool tray **111**.

The string tensioning means is more fully disclosed in my copending application aforesaid and includes a string clamp **121** best seen in FIGS. **2** and **7**. This clamp comprises, briefly, a pair of pivotally supported elongated members **122** and **123**, pivoted intermediate their ends about parallel axes and having flat elongated surfaces **126** and **127** in closely spaced substantially parallel planes parallel to the pivotal axes. The members are here mounted by pivot pins **128** and **129** to a normally vertically set supporting plate **131** to lie substantially coplanar with the line of tensioning with string **14** with the string mounted on an upper end of member **122** and extended between surfaces **126** and **127** whereby the tensioning of the string will effect rotary displacement of member **122** about its pivot **128** so as to cause a movement of the opposed surfaces into clamping relation on the string. The latter result is obtained by mounting pivot pins **128** and **129** in longitudinally offset relation. As will be observed from FIG. **2**, pivot pin **128** is at an elevation higher than pivot pin **129** so that rotation of member **122** in a clockwise direction, as viewed in FIG. **2**, will cause an opening up of the space between surfaces **126** and **127**, and contrariwise, counterclockwise rotation of member **122** will cause a closing of this space.

Preferably, one of the members, here member **122**, is provided with a handle **132** which projects forwardly from the bottom end **133** of the member for manual engagement and displacement of the members to open position of the surface for receipt or removal of the string. Also, member **122** is recessed at its upper end to form a V-shaped string centering groove **134** and means is provided at the lower end of the clamp for locating the string between the clamping surfaces **126** and **127** centrally thereof. The latter means here comprises a string engaging stop **136** adjacent the lower end of member **122** and against which the string may be readily positioned when the surfaces are opened. After insertion of the string, release of handle **132** will permit the

sections to automatically rotate to string clamping position and the ensuing tensioning of string **14** and torque applied to member **122** will cause the surfaces **126** and **127** to firmly clamp the string therebetween. Due to the long length of string contained between the surfaces, high clamping force can be readily obtained without danger of crushing or otherwise damaging the string. In stringing a racket a considerable length of string is used. In the case of the present clamp, the long length of string depends from the bottom of the clamp well out of possible entanglement with other portions of the machine.

What is claimed is:

1. In a racket stringing apparatus having an open racket head frame holding fixture and means for tensioning a string drawn across the open area of said head frame, said fixture comprising;

an open center frame member having an annulus dimensioned for circumscribing the racket head frame;

a plurality of head supporting members mounted on said member for movement across said annulus for engagement with and for radial support of said head frame;

means mounted on said frame member for supporting a string clamp for movement to a succession of parallel positions across the open area of said racket head frame parallel to the longitudinal and transverse axes thereof;

said last-named means comprising a pair of guides positioned parallel to the longitudinal axis of the racket head frame adjacent opposite sides thereof;

a second pair of guides positioned parallel to the transverse axis of the racket head frame and adjacent said yoke and distal ends thereof;

carriage members formed for longitudinal reciprocation on said guides;

a rod having opposite ends secured to said carriage members and being adapted for mounting of said clamp along the length thereof;

said annulus being formed with opposed substantially flat planar surfaces;

said supporting members being mounted on one surface; and

said guides comprising rails mounted on the other of said surfaces.

2. The apparatus of claim **1**, and a string clamp mounted for longitudinal reciprocation on said rod and comprising:

a pair of opposed sections adapted to receive and clamp therebetween a string to be tensioned and having opposed recesses dimensioned for fitting about opposed portions of said rod for longitudinal reciprocation thereon and for movement together into locked position on said rod; and

manually operarble means for displacing said sections from and to each other to respectively permit movement of said sections along said rod to desired position and to receive a string therebetween, and to simultaneously lock said sections in position on said rod and to clamp said string.

3. The apparatus of claim **2**, said recesses being positioned adjacent one end of said sections, said sections being formed at their opposite end to receive said string; and said manually operable means having connections to said sections intermediate said ends.

4. The apparatus of claim **3**, said means comprising: a lever having a loss motion pivotal connection to one of said sections, the other of said sections and lever having an interfitting cam slot and follower connection whereby arcuate displacement of said lever about said pivotal connection will effect said displacement of said sections to and from each other.

5. The apparatus of claim **3**, and spring means mounted to said sections and urging their separation.

6. The apparatus of claim **5**, said spring means being mounted adjacent said opposite end of said sections to normally produce fulcruming contact of said one end of said sections in the movement of said sections to and away from each other.

7. The apparatus of claim **6**, said manually operable means and spring means permitting manual separation of said sections at said one end for mounting on and removal from said rod.

8. A string clamp for mounting on a string clamp supporting rod of a racket stringing apparatus comprising:

a pair of opposed sections adapted to receive and clamp therebetween a string to be tensioned and having opposed recesses dimensioned for fitting about opposed portions of said rod for longitudinal reciprocation thereon and for movement together to locked position on said rod;

manually operable means for displacing said sections from and to each other to respectively permit movement of said sections along said rod to desired position and to receive a string therebetween, and to simultaneously lock said sections in position on said rod and to clamp said string;

said recesses being positioned adjacent one end of said sections with said sections being formed at their opposite end to receive said string;

said manually operable means comprising a lever having connections to said sections intermediate said ends, one of said connections being a loss motion pivotal connection and the other of said connections comprising an interfitting cam slot and follower whereby arcuate displacement of said lever about said pivotal connection will effect said displacement of said sections to and from each other;

spring means mounted adjacent said opposite ends of said sections and urging their separation and normally producing contact fulcruming of said one end of said sections in the movement of said sections to and away from each other; and

said manually operable means and said spring means permitting manual separation of said sections at said one end for mounting on and removal from said rod.

9. A racket stringing apparatus comprising:

a member dimensioned for circumscribing and supporting the open head of a racket frame having a plurality of circumferentially spaced openings therethrough;

means for engaging and tensioning a string drawn through one of said openings and across the open area of said head frame;

means supporting said member for rotation about an axis centrally of said racket head and perpendicular to the plane thereof; and

a string guide mounted on said member in position to align the pull of said string with the length of said one opening and to dispose the line of pull between said guide and tensioning means to intercept said axis;

said guide being positioned externally of said racket head frame and being formed to provide said alignment of pull when tensioning said string through substantially all of said openings and in each instance to automatically align the line of pull between said guide and tensioning means to intercept said axis.

10. The apparatus of claim **9**,

said guide comprising a roller member positionable on said member adjacent to and having its periphery aligned with each of said openings.

11. The apparatus of claim **10**,

said member having a plurality of peripherally spaced openings; and

said roller member having a shank formed for demountable positioning in each of said last-named openings.

12. The apparatus of claim **9**, said last-named means comprising:

a tool tray secured to said member in dependent substantially parallel relation thereto;

a shaft secured to and depending from said tray coincident with said axis; and

a bearing journaling said shaft for rotation.

13. In a racket stringing apparatus having a racket head frame holding fixture and means movable with respect to said fixture and having a string engaging clamp for securing a string for tensioning in the racket head frame, said clamp comprising:

a pair of elongated members mounted in side-by-side relation and each pivoted to said means intermediate its ends about parallel axes, said members having elongated confronting surfaces mounted in closely spaced substantially parallel planes parallel to said axes;

said members being mounted to said means substantially coplanar with the line of movement thereof for tensioning said string and being positioned for threading of said string over and upon one end of one of said members and between said surfaces whereby the tensioning of said string will effect rotary displacement of one said member about its pivotal axis; and

said pivotal axes being longitudinally offset from each other whereby said rotary displacement of said one member will produce an automatic clamping action of said string between said surfaces as a function of the tension imparted to said string.

14. The apparatus of claim **13**,

said one member having a handle portion for manual engagement and displacement of said members to an open position of said surfaces for receipt or removal of said string.

15. The apparatus of claim **14**,

said one member being formed at said end for centering said string thereon; and

means on one of said members for locating said string between said surfaces centrally thereof.

16. The apparatus of claim **15**,

said last-named means comprising a string-engaging stop adjacent the opposite end of said one member.

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